EMERGENCY GENERATING AND CHARGING EQUIPMENT

Contents

1. GENERAL

1.1 This section provides REA borrowers, consulting engineers and other interested parties with a guide in selecting suitable emergency generating and charging equipment. Also included is a discussion on the economic benefits obtained through longer subscriber loops by stabilizing the central office voltage. This section is being revised to update certain material and to remove maintenance subjects. Specific maintenance procedures can be found in the Telephone Operations Manual, Section 1286.

1.2 Storage batteries have customarily been used as a source of reserve power to maintain uninterrupted operation of central office facilities in case of failure of the commercial source of power. The capacities of such batteries are normally chosen so that they will sustain operation of the central office under busy hour conditions for a period of either five or eight hours as specified in the COE contract to a final voltage as specified by the dial equipment supplier.

1.3 Under present-day circumstances such as discussed in paragraphs 2 and 3, the storage batteries often prove inadequate to hold the voltage at the level required to insure uninterrupted operation of the central office. The provision of emergency generating and charging equipment is warranted in such instances.

1.4 There are alternate means of maintaining the office voltage for an extended interval of time. However, a discussion of these other means is beyond the scope of this section.

2. GENERAL NEED

2.1 With the prevalence of power shortages, the possibility of prolonged power failures is always present. Careful consideration of standby equipment with automatic transfer is essential to ensure dependable telephone service.

2.2 Where the commercial ac power supply is not extremely reliable, some other method of stabilizing the office voltage must be used. The use of emergency generating equipment with automatic transfer is one method of maintaining a fixed office voltage.

2.3 As an added assurance of service continuity more than one charger may be provided. For common control central offices, REA Form 524 requires that either two chargers each capable of carrying the full load or three chargers each capable of carrying half the office load be provided. One or the other of these arrangements may be desirable for larger size direct acting offices. Where more than one charger is used, they should be connected on a load sharing basis so that if one fails, the other will pick up the full load (or half the load in the case of three chargers). As a minimum for direct acting offices, two smaller chargers may be used whose combined capacity exceeds the busy hour office load. In case of failure of one, the remaining charger would be capable of recharging the batteries during periods of light traffic.

2.4 A standby ac generator is also required to extend loop limits. Most direct and common control systems will not provide 1900 ohm operation except under float voltage conditions (51 to 52 volts).

3. ADVANTAGES

3.1 An extension of subscriber loop limits is possible with most types of central office equipment accepted by REA by maintaining the office voltage at 51 to 52 volts. With a constant office voltage of 51 to 52 volts the maximum subscriber loop, in most cases, is 1900 ohms including the telephone set.

3.2 The economic advantage of longer subscriber loops is found in permitting more extensive use of finer gauge cables and eliminating the need of range extension devices on loops less than 1900 ohms. Discussion of loop limitations under various conditions is included in REA TE&CM 325, "Application Guide for the Preparation of Detailed Step-by-Step Dial Central Office Equipment Requirements."

3.3 An added economy with a standby power plant is a reduction in the busy hour battery reserve. Where a five- or eight-hour reserve would be specified without a standby generator, a three-hour reserve is adequate when a fixed standby power plant is provided. As an example, where the busy hour current drain is calculated at 100 amperes and a five-hour battery reserve is required without a standby power plant, the five-hour battery reserve must be 654 ampere-hours for a final voltage of 1.84 volts per cell. With a standby power plant and a three-hour reserve, a 466 ampere-hour battery would be adequate. In both cases, the next larger standard size should be selected, but the savings in the battery cost could substantially aid in the purchase of an engine generator or an extra charger. This savings can be as much as 50 percent where a three-hour reserve is used instead of an eight-hour reserve and as much as 30 percent for a three-hour rather than a five-hour reserve.

3.4 During any type of emergency, including those which fall under civil defense, it is essential to maintain telephone service over as wide an area as possible. An auxiliary power plant would add assurance that telephone service would not be entirely disrupted and in addition, might be used to provide needed power to a community emergency aid station in the event of a general commercial power failure.

4. TYPES

4.1 Engine generators are manufactured in both ac and dc models. The recommended models are the ac type with 120/240 volt, 60 hertz, one or three phase output.

4.2 Gasoline, LP gas, natural gas, and diesel engine-driven alternating current generators are available and may be of the air-cooled or water-cooled variety. A detailed description of these various types is given in paragraph 5.

4.3 The machine selected for a particular application must have electrical output characteristics the same as those of the primary source of power. Machines with outputs from 500 to 3,500 watts are normally designed for 120 volt, 60 hertz, single-phase operation. Generators with outputs of 3,500 watts or more are designed for 120/240 volt, 60 hertz, single-phase or three-phase operation.

5. FUEL CONSIDERATIONS

5.1 Since the type of fuel used for emergency generating plants is an extremely important consideration, it should be realized that each type has characteristics advantageous to one application, but disadvantageous to another. The major influencing factors for fuel selection are: (a) availability; (b) initial cost; (c) maintenance costs; (d) local fuel storage regulations; and (e) performance requirements.

5.2 Gasoline plants have a lower initial cost than diesel types. Gasoline plants start quickly and dependably over a wide range of temperatures and deliver full rated power. The major disadvantage of gasoline plants is the difficulty in storing the fuel over extended periods of time. This being the case, special precautions must be taken and minimal quantities kept on hand.

5.21 Where recommended by the manufacturer of the engine-generator, low-lead or nonleaded gasoline should be used. For generator sets which operate at constant speeds, lead deposits in the combustion chamber are difficult to "blow out" through the exhaust ports unlike engines operating at variable speeds. Using nonleaded gasoline helps reduce problems such as: cylinder head deposits, sticking or burned valves, spark plug fouling, piston wear, ring wear and sticking, cylinder wall wear, and poor oil control after ring fouling.

5.22 If it is desired to change from leaded to nonleaded gasoline in an existing engine, it is necessary to remove all lead deposits from the engine to prevent preignition from causing severe damage to the engine.

5.3 Gaseous fuels come in two major types: piped-in and LP gas. The former may be natural or manufactured, and the latter a mixture of propane and butane which is supplied under pressure in tanks. No storage problems are encountered with piped-in gas and it is, therefore, quite simple to use. Because LP gases are heavier than air and highly combustible, their storage comes under strict insurance underwriters' regulations. In areas where low temperatures may be encountered, a larger mix of propane should be used. This is the case because butane has a boiling point of about 14°F (-10°C), whereas propane's boiling point is about -47°F (-44°C).

5.4 Gaseous fuel contributes to longer engine life and reduced maintenance due to more complete, efficient combustion. Since this fuel contains no lead, there are minimum carbon deposits, less sludge formation, longer valve life and no combustion chamber deposits. In that gaseous fuels remain fresh in storage, starting is quicker after long shutdowns.

5.5 Before deciding on a gaseous fuel, the BTU content must be at least 1100 BTU's per cubic foot. Natural and bottled gases meet this requirement, but some manufactured gases may run as low as 450 BTU's. When a lower rated fuel is used, the manufacturer should be contacted regarding the necessary derating of the plant's capacity.

5.6 Diesel engines are constructed considerably heavier and sturdier than gasoline models which results in higher initial costs. However, the longer life and lower maintenance may justify these high costs. Generally only diesel engines are available in the larger sizes. Diesel fuels are safe and relatively easy to store in sufficient quantities.

5.7 Diesel fuel costs less per gallon and has a higher BTU content than gasoline. Fuel consumption is considerably less and the efficiency and fuel savings increase with the size of the unit.

5.8 The heavier weight construction of diesel engines plus the absence of plugs, points and condensers reduces maintenance costs over those of gasoline engines. Diesel engines offer prompt starting, operating speeds are reached quickly, and heavy loads are handled easily.

6. CAPACITIES

6.1 The output capacities of the air-cooled gasoline or LP gas powered units range from about 1000 watts to 15,000 watts, and those of water-cooled units are from 5000 watts upwards.

6.2 Air-cooled diesel powered models range in output capacity from about 3000 watts to 15,000 watts; water-cooled units from 5000 watts upwards.

6.3 Generator ratings listed by the manufacturers should be considered carefully. Rating methods have not been standardized; therefore, a generator rated at 15 kw, for instance, may be unable to supply this load except for a short time. Comparison of the engine horsepower rating and the generator wattage rating should show a ratio of approximately two to one, i.e., two horsepower to every kilowatt. It is also important to remember that even though a 15 kw unit rated at less than 30 horsepower may develop the full 15 kw output when new, as the unit ages and wears the capacity will drop.

6.4 If the altitude of the installation is greater than the altitude of the manufacturing site, the unit should be derated about 4 percent per thousand feet above sea level.

7. APPLICATION

7.1 When calculating the generator size required, at least part of the central office lighting load should be included so that it is possible to operate some lights and soldering equipment as well as provide the power requirements for the charger. Frequently, a generator one size larger than required for the basic equipment drain is sufficient and can be obtained for small added cost. Providing power for air conditioning, heating and full lighting will increase the cost of a generator substantially but may be desirable in some cases. Air conditioning and/or heating may be mandatory in certain areas for certain equipment, especially for electronic common control offices. If the central office equipment is located in the headquarters building, it may also be desirable to have sufficient generator capacity to operate office machines and computer equipment although inverters are normally provided for this purpose.

7.11 Where long range growth and power requirements are uncertain, it is advisable to provide standby generator capacity for a shorter time period. When the load reaches this smaller unit's capacity, it could be transferred elsewhere, sold or traded in.

7.2 If the plant is to be mounted inside the central office building, suitable provision must be made for the entrance of cooling air and for the discharge of exhaust gases into the outside air. Openings for ventilation should be placed to allow the cool air to enter, be forced through the engine cooling system and exit without circulating around the room.

7.3 Some means, such as described in paragraph 9.15, must be provided to prevent voltage from being fed back onto the commercial power facilities to prevent accidental contact with a live line presumed to be unenergized.

7.4 Portable units are not recommended in areas where the year-round weather conditions will not permit transporting the unit between offices. When emergency power is required, it may be needed in more than one office at the same time. Under such circumstances portable units are impractical.

8. INSTALLATION

8.1 If the central office building is to be new construction, or an addition to an existing building is proposed, it may be advantageous to install the auxiliary power plant as a part of the building contract if the plant is to be permanently mounted in a separate room of the central office building. If a separate room of the CO building is used, it should be enclosed by firewalls and entrance should be from the outside of the building only.

8.2 A clean, dry, well ventilated location must be chosen for placement of the auxiliary power plant. The location chosen should preferably have minimum temperature variations. Locations where temperatures are unusually high should be avoided because inefficient cooling will result. Where temperatures fall below 50°F (10°C), special accessories such as electric water jackets or manifold heaters will be needed to insure dependable automatic starts. Since moisture reduces plant efficiency, the power plant must be located where rain and moisture cannot get to it. For outside installation a weather housing should be specified.

8.21 In areas where flooding is prevalent, basement locations must be avoided. Rooftop installation has advantages such as less noise, rapid dispersion of exhaust fumes, less likelihood of vandalism, and less snow bank problems as well as no flooding. Of course, when a rooftop installation is considered, the structure must be able to support the generator weight.

8.3 Enough space should be allowed around all sides of the plant for cleaning, ventilation and servicing. The position should be chosen so that ducting to the inlet and outlet openings can be conveniently arranged. Careful consideration must be given to fuel, exhaust and electrical line routing when choosing a location. Building codes must be considered also.

8.4 Two louvers with automatic shutters are often necessary in the space provided for the auxiliary power plant; one for air intake and the other to permit escape of the warm air created by the power plant. These openings are in addition to those required for discharge of exhaust gases.

8.5 Mufflers are necessary in most cases to prevent noisy exhausts. They are especially important when the central office is located in a residential area. Since a cool muffler creates undesirable carbon deposits, the muffler must be installed as close as practical to the engine.

8.6 When the installation of the ac plant is made a part of the building contract, the plans should include provisions for a fuel line and for a control box to permit transfer features. Mounting needs including facilities for bolting the unit to the floor or pier must also be considered by the architect or engineer. Vibration damping should also be provided.

8.7 Smaller units, 10 KW or less, should be installed on a concrete foundation equipped with anchor bolts. In some cases, steel beam sections will make a satisfactory base. For large plants, which are equipped with steel skids, a separate foundation may not be necessary although it is recommended. In any case, make certain that the floor will support the weight of the plant.

8.8 Regardless of the type of unit considered, the suppliers of auxiliary power plants should be contacted and their help solicited in determining installation requirements. Most suppliers provide sample specifications for each size plant and each provide forms that, when completed, list all information required for the purchase of an adequate standby plant. The local representatives of the suppliers can lend assistance in determining plant requirements.

8.9 When not made part of a building contract, standby power plants should be purchased under a separate special equipment contract. In cases where the supplier of the power plant has an installation force, it may be more convenient and possibly more economical to purchase the unit installed. The supplier assumes full responsibility of all phases of the work including delivery, installation and testing of the plant.

9. GENERAL SPECIFICATIONS

9.1 Regardless of the size of the plant or the type of fuel used to power the plant, the following general specifications should apply as minimal.

9.11 The prime mover should deliver at least two horsepower at rated governed RPM for each kilowatt of the generator's full output rating.

9.12 The prime mover's ignition system and associated electrical equipment should be equipped with adequate shielding against radio frequency interference.

9.13 Adequate speed regulation should be provided to maintain output voltage under full load to within 10 percent of the output voltage under no load. The frequency under full rated load should be kept within 3 Hz of the no load frequency.

9.14 It should be possible to vary the output voltage $\pm$ 5 percent of rated voltage under full load regardless of generator speed.

9.15 An automatic switchover panel should be provided with an automatic transfer switch with a fail safe feature to prevent voltage from being fed back onto the line. This switch must be listed with the Underwriter's Laboratory.

9.16 Cold start generators should be under the protection of a timer to prevent starting of the prime mover for at least 5 seconds after failure of commercial power. This delay should be adjusted to suit the commercial power characteristics. In offices where volatile memories, such as found in certain ticketing equipment, are used, special uninterruptible inverters may be needed to apply continuous power to these items.

9.17 Batteries for starting the prime mover of cold start generators should be the "dry charged" type placed under trickle charge after installation. The trickle charger should be regulated to vary the charging current over the required range to provide a full charge without overcharging.

10. RECOMMENDED FEATURES

10.1 All of the engine generators presently available have various features which may or may not be included in the base price of the generator. These features vary with different manufacturers and with models as well as capacity and the type of fuel required. Which options to include will be determined by each specific application, but in most cases the plants should be equipped with the following features.

10.11 Load Transfer - Since the power plant is used for emergency power, this control is needed to automatically start the plant when the commercial power fails. Load transfer controls can also be used to insure that the plant runs for at least 15 to 30 minutes once started. This assures that it reaches operating temperature, evaporates moisture from the oil, etc. The cost of this control is largely dependent upon the size of the plant and added optional equipment desired, such as a time exerciser and/or time delay relays, etc. These load transfer switches should have the safest arrangement of controls possible and all live contacts should be out of reach of telephone company personnel. In any case, they must be listed with the Underwriter's Laboratory and kept locked and access given to authorized personnel only.

10.12 Time Exercisers - This option is part of the load transfer equipment and causes the unit to start automatically at timed intervals, run for a short time and then shut off. It is necessary in unattended exchanges to determine that the emergency plant will start. This equipment should be set to operate at least once a week for at least 30 minutes running time. Exercising should be done under full load to lubricate internal parts, remove moisture, assure proper starting, keep fresh fuel in the carburetor, bring the engine to operating temperature and recharge the battery. Long periods of no load operation can cause cylinder wall glazing and poor ring seating and attendant high oil consumption. However, the generator should not take over the load until it has reached running speed.

10.13 Time Delay Relay - This relay prevents the plant from transferring to the load when outages lasting a moment or two occur. (See paragraph 9.16.) Conversely, it also prevents the unit from retransferring immediately when the commercial power is restored in case the restoration should be momentary. Returning power often fluctuates for several minutes before returning to its nominal value. The central office should not be returned to commercial power until these fluctuations have ceased. It is recommended that a 15-minute delay be used. If the time it takes for these fluctuations to steady is known, a shorter delay may be used.

10.14 Frequency Meter - This meter is used to monitor the output of the plant to determine that the 60 Hz output does not vary more than plus or minus 1.5 Hz.

10.15 Alarms - In the event that the plant fails to start, either during the period selected by the exerciser or as a result of a commercial failure, a means of transmitting an alarm to an attended office must be a part of the system. This can be accomplished by an applique circuit that connects to the existing central office alarm circuitry. Alarms can also be used to indicate low oil pressure, high temperature, low fuel level, etc.

10.16 Test Switch - A test switch to simulate a commercial power failure is required so that the plant can be manually turned on and off for maintenance checks. There should be an on-off switch on the generator set to permit testing the engine without interrupting normal ac functions.

10.17 Underground Fuel Tank - A buried fuel tank may be desirable for the permanently fixed large size water-cooled plant and the medium range LP gas-fueled plant. For the smaller units, 4 KW or less, an above ground tank with a capacity of 10 to 55 gallons should be adequate. Where longer outages can be reasonably expected, a tank with a capacity for 120 hours full load operation should be provided.

10.18 Battery and Trickle Charger - The battery required may be either a single 12-volt battery with a 55-ampere hour capacity needed with the smaller engine generators or as many as four 6-volt batteries for larger diesel or gasoline units. A battery and a means of keeping it charged is a necessary part of the equipment. Provision for mounting space for both the battery and charger should be given consideration, either as a part of the transfer panel or wall mounting space inside the building if the plant is mounted externally. The batteries should be mounted on a wood or metal platform as near as possible to the generator, but not beneath it. Battery cables should be the proper size and kept as short as practical.

10.19 Crankcase or Water Jacket Heater - Where cold weather occurs during the winter months, a water jacket or crankcase heater should be ordered with the engine-generator if the plant is to be mounted outside of the building or inside in an unheated room of the central office building.

10.20 Running Time Meter - This instrument indicates the accumulative operating time of the engine-generator. This is important in performing periodic maintenance.

10.21 Day Tank - A gravity feed priming tank should be installed to assure quick starting of gasoline engines and certain diesel models. While the plant is not being operated, evaporation of gasoline may occur in the carburetor or fuel in the supply line may drain back into the main tank causing a delay in starting, since the fuel must again be pumped from the tank to the carburetor. The day tank will replace this fuel by means of gravity flow.